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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/292,186	04/15/1999	DANIEL M. KINZER	IR-1609-(2-1	3190

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EXAMINER	
HU, SHOUXIANG	

ART UNIT	PAPER NUMBER
2811	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	09/292,186	KINZER, DANIEL M.	
	Examiner	Art Unit	
	Shouxiang Hu	2811	

– The MAILING DATE of this communication appears on the cover sheet with the correspondence address –

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *26 October 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *9-13* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *9-13* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 9-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Floyd'716 (Floyd et al., US 6,090,716) in view of Love (US 4,516,143) and/or Bulucea (Bulucea et al., US 5,701,023).

Floyd'716 discloses a trench-type power MOSFET device (particularly see Fig. 10, and col. 2, lines 22-67, in view of Fig. 1 and col. 1, lines 12-50), comprising: a vertical invertible channel composed of a first conductivity type (52; p type) between a heavily doped source region of a second conductivity type (50; n type) and a heavily doped drain region (or drain layer) of the second conductivity type (54; n type); a gate oxide (56); a source contact (66) in contact with the source region, wherein the layer of the channel material (52; i.e., a channel layer, a body layer/region, or, a channel-forming layer) is a P-type layer (an epitaxial layer) and has a p-type doping concentration that is substantially uniform along its full length (see Fig. 11), wherein the doping of the P-type layer inherently allows reverse voltage to be blocked therein, since in the device it is the only layer that is lightly doped among the relevant layers (50, 52 and 54), while all regions (in 50 and 54) of the rest of the relevant layers are always

highly conductive as they are all heavily doped (see Fig. 12); and, a polysilicon gate (58A) inside the trench.

Furthermore, since what described in Floyd'716 (see col. 1, lines 12-50) is for the making of "such transistors" which includ the one similar to what is shown in Fig. 1 therein (which is also described in US Patent 5,592,005), the doping type or net doping type of such a polysilicon gate (58A) is naturally the second conductivity type, i.e, the n-type, the same type as that of the source/drain regions, when "such transistor" similar to what is shown in Fig. 1 is formed.

In the embodiment of Fig. 10 in Floyd'716, the MOSFET device is an n-channel MOSFET (which normally has a source-channel-drain doping polarity of an n-p-n polarity type, i.e., with the first conductivity type being a p type and the second conductivity type being an n type). Although Floyd does not expressly disclose that the MOSFET device can also be a p-channel MOSFET (which normally has a p-n-p doping polarity), the examiner notes that it is well known in the art that: a MOSFET can be either an n-channel MOSFET or a p-channel MOSFET; a MOSFET design/structure which works under one polarity type is normally also workable under the reversed polarity; and, the p-n-p doping polarity type MOSFET (i.e., the p-channel type MOSFET) is desirable in various applications in the art.

Support for the above examiner's note can be readily found in the prior art, such as the following prior art references provided by the examiner: Floyd'043 (Floyd et al., US 6,069,043; see Figs. 3 and 11, and col. 7, lines 11-17) and Darwish'766 (Darwish et al., US 5,674,766; see col. 11, lines 20-22). And, the desirability for the p-n-p doping

polarity type MOSFET (p-channel MOSFET) can be further supported by applicant's admitted prior art in the instant disclosure (see the p-n-p doping polarity type MOSFET in Fig. 1).

Therefore, it would have been well within the ordinary skilled in the art at the time the invention was made to make the MOSFET device of Floyd'716 with the doping polarity being reversed, so that a MOSFET with desired p-channel type and/or improved circuit design flexibility (associated with the desired channel type) would be achieved.

Furthermore, although Floyd'716 does not expressly disclose that the MOSFET can further include a drain contact made of metal, the examiner further notes that it is well known in the art that either of metal and polysilicon can be used to form a drain contact (Support for such further note can be found in Buchanan (US 4,333,224, see the abstract, which is provided here for the convenience of the applicant). And, one of the ordinary skill in the art would readily recognize that the drain contact can be commonly formed of a metal for reducing the contact resistance (given the well-known fact that metal normally can have lower contact resistance compared with polysilicon) and/or for improving flexibility on material choices for the drain contact, as evidenced in Love (see the metal drain contact 105 in Figs. 8, 9 and 11) and/or in Bulucea (see the drain contact 50 in Figs. 7 and 24)

Therefore, it would also have been well within the ordinary skilled in the art at the time the invention was made to further incorporate a metal drain contact such as the one of Love and/or the one of Bulucea into the above doping-polarity-reversed MOSFET device, so that a p-channel MOSFET with reduced contact resistance and/or

with improved material choices/flexibility for the drain contact would be obtained, as such drain contact metal material is an art-known material that is well suited for the intended use. The selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945).

And, the MOSFET device of Floyd with reversed polarity (i.e., by simply reversing each of the n, p type regions in the device so as to become p, n type regions, respectively) would inherently have a reduced on-resistance (when compared to the conventional p-channel MOSFET such as the one shown in Fig. 1 of the instant disclosure; the same type of comparison made in the instant disclosure, see the tables on pages 3 and 4 in the specification) and the doping in the N-type channel layer would be inherently capable of blocking reverse voltage (at least to a certain degree) therein, as it would be basically identical to the structure of the instant invention with the N-type channel layer being the only layer that is substantially lightly doped, and would not have any lightly doped drift layer between the channel-forming layer and the heavily doped drain layer.

Regarding claim 10, it is further noted that it is well known in the art that it is desirable to have a source electrode in direct contact with the source region and also with the top region of the channel-forming layer (or, base layer/region) via notches extending through the source region, for improving the device stability by preventing the potential parasitic bipolar transistor therein from turning on, as further evidenced in Love (see the notches 104 and/or 106 in Figs. 10 and 11). Therefore, it would also have been

obvious to one of ordinary skilled in the art at the time the invention was made to further incorporate the notch structure of Love into the above collectively taught device, so that a MOSFET device with improved stability would be obtained.

Regarding claims 11-13, although the above collectively taught device does not expressly disclose that the channel layer can have a resistivity of about 0.17 Ohm-cm and a thickness of about 2.5 um, and that the substrate has a resistivity less than 0.0005 Ohm-cm, it noted that these values are respectively well within the commonly recognized ranges for the relevant parameters, and that it is old and well known in the art the threshold voltage and the on resistance of MOSFET are directly correlated to the doping concentrations of the channel layer and the substrate layer and the thickness of the channel layer; and they are all well recognized parameters of importance subject to routine experimentation and optimization.

Therefore, it would have been obvious to one of ordinary skilled in the art at the time the invention was made to make the above collectively taught MOSFET device (with the doping polarity being p-n-p type), with the channel layer having a resistivity of about 0.17 Ohm-cm and a thickness of about 2.5 um and with the substrate having a resistivity less than 0.0005 Ohm-cm, through routine experimentation and optimization within the commonly recognized ranges for those parameters, so that a p-channel MOSFET with the desired threshold voltage and on-resistance would be achieved.

Response to Arguments

Applicant's arguments filed on October 26, 2007 have been fully considered but they are not persuasive, as further explained below.

Firstly, it is noted that one of the objectives of Floyd'716 (see col. 1, lines 12-50) is to make "such transistors", which include the one similar to what is shown in Fig. 1, wherein the polysilicon gate (10) has a same conductivity type as that of the source/drain regions (22, 26). Such kind of transistor is also among the "such transistors" that are described in US Patent 5,592,005, regardless whether other kind of transistor(s) may also be described therein. And, the doping of the P-type channel layer (52) in Floyd can inherently allow reverse voltage to be blocked therein (at least partially), since it is the only layer therein that is lightly doped and/or naturally substantially depleted among the relevant layers (50, 52 and 54), while all regions (in 50 and 54) of the rest of the relevant layers are always highly conductive as they are heavily doped (see Fig. 12). And, applicant's arguments fail to provide any adequate adequate evidence/support to show why the doping of the P-type channel layer (52) in Floyd cannot inherently allow reverse voltage to be blocked therein (at least partially).

Secondly, since one of the objectives of Floyd'716 (see col. 1, lines 12-50) is to make a transistor similar to what is shown in Fig. 1, in which the polysilicon gate (10) has a same conductivity type as that of the source/drain regions (22, 26), it is obvious for one of the ordinary skill in the art to recognize that the doping of n-type dopants (phosphorous; see col. 2, lines 55-60) is clearly intended in Floyd'716 to make the gate electrode to have a conductivity (at least, a net conductivity) of n type, when "such

transistor" similar to the one shown in Fig. 1 is made. Furthermore, since a driven step is also included in Floyd'716, which normally means of annealing as well known in the art, the dopants of such n-type impurities can be readily diffused into the entirety of the polysilcion layer (58) from which the gate electrode (58A) is patterned, regardless what sthe implanting energy is for the n-type dopants.

In addition, it is also obvious for one of the ordinary skill in the art to recognize that the doping of p-type dopants (boron; see col. 2, lines 60-67) is clearly intended in Floyd'716 to make the gate electrode to have a conductivity of p type, when a transistor (also included in "such transistor") similar to the one shown in Fig. 3 of US Patent 5,592,005) is made, given that none of the single gate electrodes in all of "such transistors" described in US Patent 5,592,005 requires doping of both of the n-type and p-type dopants inside the single gate electrode.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is 571-272-1654. The examiner can normally be reached on Monday through Friday, 8:30 AM to 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynne Gurley can be reached on 571-272-1670. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

SH
January 9, 2008

SHOUXIANG HU
PRIMARY EXAMINER